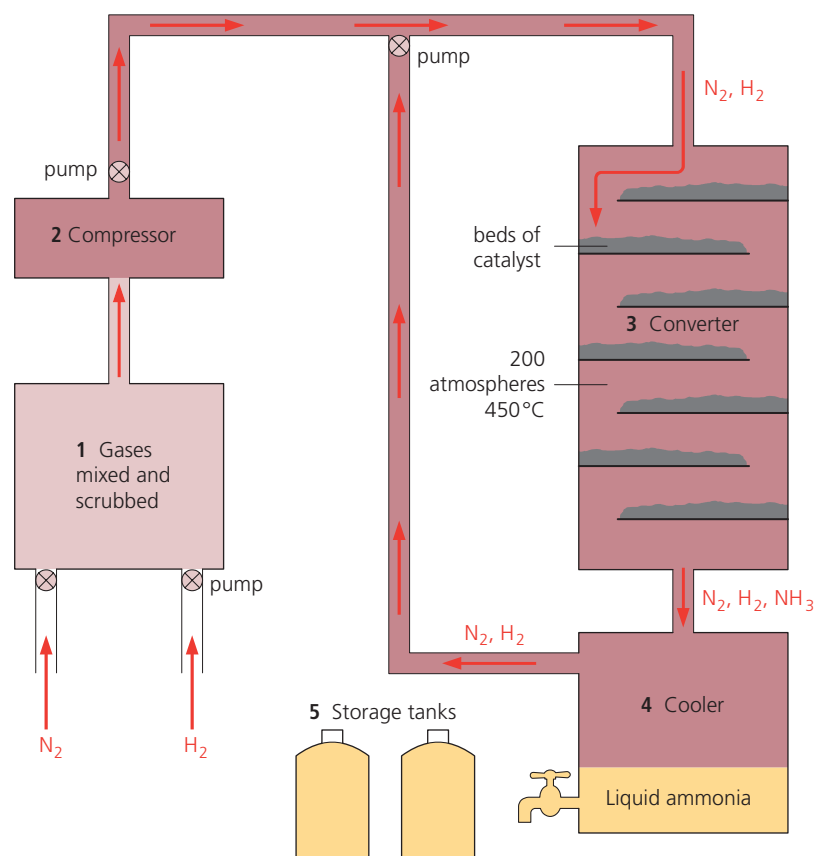


The Haber process

The process used to make ammonia is called the **Haber process**.

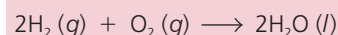


- 1 The reactants are nitrogen and hydrogen. The nitrogen is obtained from air, and the hydrogen by reacting natural gas (methane) with steam, or by cracking hydrocarbons. See the details on the right. The two gases are mixed, and **scrubbed** (cleaned) to remove impurities.
- 2 The gas mixture is **compressed**. More and more gas is pumped in, until the pressure reaches 200 atmospheres.
- 3 The compressed gas flows to the **converter** – a round tank with beds of hot iron at 450°C. The iron catalyses the reversible reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
 But only 15% of the mixture leaving the converter is ammonia.
- 4 The mixture is cooled until the ammonia condenses to a liquid. The nitrogen and hydrogen are recycled to the converter for another chance to react. Steps 3 and 4 are continually repeated.
- 5 The ammonia is run into tanks, and stored as a liquid under pressure.

Nitrogen

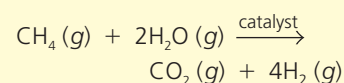
Air is nearly 80% nitrogen, and 20% oxygen. The oxygen is removed by burning hydrogen:



That leaves mainly nitrogen, and a small amount of other gases.

Hydrogen

- It is usually made by reacting **natural gas** (methane) with steam:



- It can also be made by **cracking hydrocarbons** from petroleum. For example:

